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EDITOR'S CHOICE (RESEARCH ARTICLE)

Collisional super-Penrose process and Wald inequalities

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Abstract We consider collision of two massive particles in the equatorial plane of an axially symmetric stationary spacetime that produces two massless particles afterwards. It is implied that the horizon is absent but there is a naked singularity or another potential barrier that makes possible the head-on collision. The relationship between the energy in the center of mass frame $E_{c.m.}$ and the Killing energy E measured at infinity is analyzed. It follows immediately from the Wald inequalities that unbounded E is possible for unbounded $E_{c.m.}$ only. This can be realized if the spacetime is close to the threshold of the horizon formation. Different types of spacetimes (black holes, naked singularities, wormholes) correspond to different possible relations between $E_{c.m.}$ and E. We develop a general approach that enables us to describe the collision process in the frames of the stationary observer and zero angular momentum observer. The escape cone and escape fraction are derived. A simple explanation of the existence of the bright spot is given. For the particular case of the Kerr metric, our results agree with the previous ones found in Patil et al. (Phys Rev D 93:104015, 2016).

Keywords BSW effect · Penrose effect · Collisional penrose · Black hole · Naked singularity

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